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ABSTRACT

This booklet is one in a series of instructional aids designed for use by elementary and secondary school science teachers. First, the original natural scene of the eastern portion of the United States is described, from the Atlantic Coast to the Mississippi River, as it probably was before European man invaded in great numbers. How local conditions affect plant and animal species and how variances in these species can be used to indicate subtle aspects of local environmental conditions are considered next. Finally, practical examples are presented as exercises in reading the landscape and in seeing a whole view by carefully using a few parts. (Author/PR)

NATIONAL SCIENCE TEACHERS ASSOCIATION

how to .

READ THE NATURAL LANDSCAPE IN FORESTS AND FIELDS

Millard C. Davis *Editorial Associate / National Science Teachers Association*

Landscapes are like books which inform us about the condition of our environment. Learning how to read them is a matter of finding out what to look for and how best to interpret your findings. The "characters" of this book will be mostly plant and animal "indicator species" or simply "indicators"–species which so depend on particular conditions that they indicate when these are present.

This booklet first sets the original natural scene over the eastern portion of the United States, from the Atlantic Coast to the Mississippi River, as it probably was before European man invaded in great numbers. Then, we see how local conditions affect plant and animal species and how variances in these species can be used to indicate subtle aspects of local environmental conditions. Finally, practical examples are presented as exercises in reading the landscape, in seeing a whole view by carefully using a few parts.

SETTING THE SCENE

FORESTS

In the eastern part of the United States, that territory lying between the Atlantic Coast and the Mississippi River, forest was once the natural condition of most of the land. So gigantic were the primeval forest trees that their canopies kept the trunks yards apart. Early wagons drove between them with ease, rolling over a shadowed floor that was quite free of underbrush, except where fire or death had let in the sunlight.

This association has been restoring itself again and again for millenia; today we call it the *climax stage*. Anything less permanent would be a *successional stage*. If, for instance, a fire has wiped out a section of the woods, you will find that usually grasses and forbs (herbaceous plants such as dandelion and clover that are neither a grass nor grasslike) come in, shrubs follow, other trees enter, and finally the old climax types find conditions just right for their return. This is called "succession." A climax stage holds on in semiperpetuity until disaster. Then successional stages come in and prepare the land for other vegetational types which succeed them, as succession begins again.

One of the primary mechanisms forcing this transition is shade, or shade tolerance. Forbs develop best on somewhat barren soil. Grasses can usually tolerate the shade of forbs, but they in turn create a turf which keeps further forb seeds from reaching the soil. Grass will also shade out the young forb of spring. (So it is that one of the best defenses against a weedy lawn is one bearing a thick carpet of grass. Put in grasses right for the area and skip herbicides and digging tools.)

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Grass stabilizes the soil, holding it in place and allowing minerals to collect. Minerals are even brought to the surface by grass, through the roots into the blades, and by travel with earthworms. Shrubs do well in the richer soil, where they flourish and shade out the grasses. Small trees, such as flowering dogwood and smooth sumac, arrive, spread their canopies over the shrubs, and begin to take over.

And so it goes. Larger, taller, longer-lived trees follow, and in time a climax forest has returned. With this in mind, you can see that a major part of your background for reading the natural landscape will consist of determining the climax and the successional stages of your area.

The vegetational physiography of our country can be divided into a few large plant "formations" or plant-animal "biomes." Our concern centers on the details of only one, however, the Deciduous Forest Formation, which embraces most of the territory east of the Mississippi River. This forest can be divided into nine major regions, according to E. Lucy Braun [1], whose method of classification is followed in the Regions section of the following table of succession. Other classification schemes can be used, of course, especially as a matter of gaining perspective in interpreting the natural landscape in its larger aspects. Whatever way you choose, the plants will stay in their places. The important thing is to get a good approximation of your place in space and time, botanically speaking.

Two notes of caution are in order. First, the Mixed Mesophytic Region has the widest diversity in species and species-groupings ("*associations*"), but only one example is given. (Mesophytic refers to plants that grow under conditions of medium moisture.) Second, the tree-shrub stage, which is transitional from herbaceous (nonwoody plants) stages, will vary under local regimes (as will climax species, of course). They are included to indicate the sorts of trees and shrubs that succeed each other and to give you a feel for the size and shape of the species involved. When you find some of these species, you will feel more assured that your interpretation is reasonably accurate.

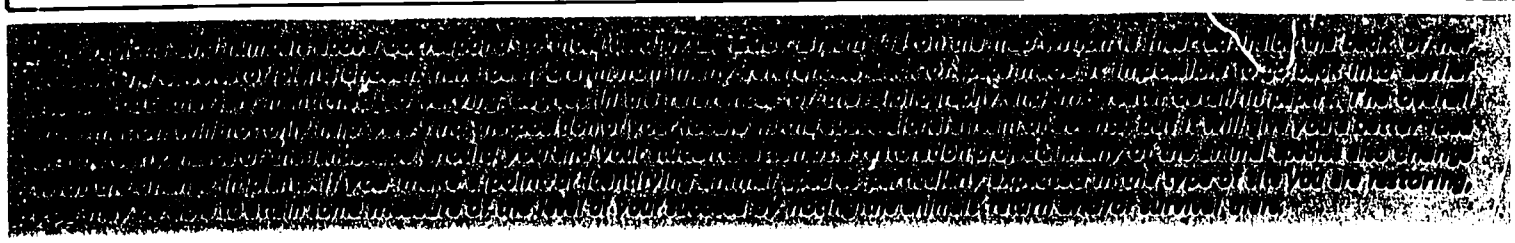
You might have your students plot the theoretical botanical regions on a map of their state or area. After this you might arrange a field trip or examine older, less disturbed, local places for plant species. See how the list conforms to the table. You will want to check in books such as E. Laurence Palmer's *Fieldbook of Natural History* [5] to eliminate known "guests," such as Eurasian species. You should also consider, if possible, the relative amounts of territory occupied by different species in a grouping. For instance, in a woodland canopy (topmost layer, made up of crowns of trees), compare the numbers of oaks and hickories versus those of red maple and black tupelo. In a climax oak-chestnut forest we should find more of the former, as dominant species, with the maple-tupelo species possibly as subdominants.

Let the students now try the same field exercise in suburban and urban landscaped areas, even in wooded parks. This exercise will help them realize how much our landscape has been changed by man's hand. Probably a few students will come out asking, "Why do landscapers choose the trees, shrubs, and flowers that they do?"

Some of your best woodland observations may be made during winter, incidentally, when factors such as density of trunks per area, relative sizes and patterns of arrangement, and the shapes of individual crowns can be seen more easily. In addition, you are most easily able to compare these to the overall topography, so important to interpreting the scene. Photography during winter has certain distinct advantages, and planning for field trips may be based upon this as a major event.

TABLE OF SUCCESSION

NO.	REGION	CLIMAX SPECIES	SPECIES SUCCESSIONAL FROM HERBACEOUS COMMUNITIES	
1.	Mixed Mesophytic (example is the beech-oak association)	American beech Sugar maple Canada hemlock Northern red oak	Tuliptree Yellow birch Common pewpaw Striped maple Black locust	Sassafras Persimmon Hawthorn Smooth sumac
2.	Western Mesophytic	Oak-hickory Oak-tuliptree Beech-chestnut Prairies Cedar glades	Varies widely depending on locale, since the region is a mosaic of several of the associations of the climax groups.	
3.	Oak-Hickory	Oaks: red, black, white, scarlet, bur, post, etc. Hickories: shagbark, pignut, bitternut, etc.	Sweetgum Hackberry Flowering dogwood Black locust	Sassafras Persimmon Hawthorn Eastern red cedar
4.	Oak-Chestnut	American chestnut Chestnut oak Oaks, hickories	Red maple Black tupelo American hophornbeam Flowering dogwood	Sassafras Persimmon Hawthorn Eastern red cedar
5.	Oak-Pine, Oak-Hickory	Oaks: white, southern, red, black, post, etc. Pines: loblolly and yellow Hickories: white and pignut Sourwood Sweetgum	Flowering dogwood Maple-leaved viburnum Blackhaw New Jersey tea Sweetgum	
6.	Southeastern Evergreen	Southern magnolia Live oak and other oak American holly	Longleaf, loblolly, and slash pine	Sourgum Sweetgum
7.	Beech-Maple	Beech Sugar maple	The region was covered by the most recent or Wisconsin ice sheet, some 20,000 years ago. Its youth has meant that large areas are occupied by these stages. So we find bog, oak-hickory, oak-chestnut, and cedar-swamp associations, to name a few.	
8.	Maple-Basswood	Sugar maple Basswood	Oaks Hickories Pines Aspens Birches Dogwoods	Wild plum, sassafras, willow (*Salix cordata*), cottonwoods, hornbeam, juniper, bearberry, blueberry, laurel
9.	Hemlock-White Pine-Northern Hardwoods	Hemlock White pine Sugar maple Beech Basswood Yellow birch	Aspen Balsam poplar Paper birch Gray birch	Spruce, Larch, White cedar } bogs Alder-willow, Elm-ash-maple, Red-berried elder } streamsides



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FIELDS

The eastern United States has been so thoroughly cut over and bruised since European man arrived that the great majority of us today are far more familiar with fields than with forests. As a species we seem to *prefer* the open places with scattered groves of trees.

Fields occur under a wide variety of conditions and form distinct little units. Some of the more familiar are: pastures, abandoned or "old" fields, railroad lines and right-of-ways, "weedy" roadsides, and remnant prairie (Pennsylvania and westward). Most of these units show our European origins by the number of Eurasian plants present. Thus New England fields contain not only the native milkweed, asters, goldenrod, and black-eyed susans (from the west) but also the "exotic" daisies, red clover, Queen Anne's lace, chicory, dandelion, buttercups, and many others. Railroad lines, less subject to our direct planting, tend to be excellent refuges for native flora, particularly in the Midwest.

As with the forests, a major aspect is succession. Fallow pastures and abandoned fields go through developmental stages in which we usually find the following types succeeding each other (examples are given without respect to climate, soil, or other situational but important differences):

1. Annuals and biennials. Herbaceous; may be called "pioneers," as they invade "disturbed" soils in particular. Examples: crabgrass and horseweed. Ragweed may also come in particularly early, especially on loose moist soil.
2. Perennials (herbaceous). Need much sunlight; their roots do not go down deep but are matted; roots overwinter while the upper parts die down. Examples: broomsedge grass, goldenrod, tick trefoil, clover, sensitive fern (which takes its name from a sensitivity to cold, such as autumn frosts). Trefoil and clover are legumes which, associated with certain bacteria, fix nitrates in the soil. These nitrates not only feed this stage but encourage development of later stages. Grasses begin to dominate and eventually take over, preparing the way for shrubbery and trees. Eastern red cedar is likely to appear. Dr. H.R. DeSelm of The University of Tennessee points out that in certain parts of North Carolina and Tennessee, for instance, "the grass stages are usually enriched by shrubs, such as blackberry and raspberry, and vines, such as catbriar, Japanese honeysuckle, and trumpet creeper." [2]
3. Thicket. Shrubs and small trees, "rough stuff"; woody. Many of these have arrived as seeds, carried by birds and mammals. Thus you can often identify a fence line through a field by the string of shrubs and trees there, seeded in by birds which sat on the fence and dropped seeds. Examples: blackberry, raspberry, bayberry, grey or panicled dogwood, poison ivy, Japanese honeysuckle, and grey birch or aspen. Again, for appropriate places of North Carolina and Tennessee, Dr. DeSelm notes that "thicket stages follow the seeding into fields of tree and shrub species. There may be an intermediate, temporary stage, however, in which a broomsedge grass is completely covered by honeysuckle, trumpet creeper, and poison ivy before pines, cedars, or hardwoods–such as sassafras–take over." [2]

Though many of these same species are common preludes to other climax associations, as one approaches extremes of cold, moisture, and other factors, the stages vary even more. For instance, the beginnings of a swamp forest may include arrowleaf smartweed among the annuals, common rush among the perennials, and buttonbush and sandbar willow in the thicket stage. Sandbar willow, incidentally, extends new runners and sprouts laterally each growing season. You can have your students age a clone (a group of asexually produced offspring) by noting successive sizes of sprouts from the tallest.

BEING MORE SPECIFIC

LOCAL TOPOGRAPHY AND PLANTS

To some degree we can treat geographic or geologic features of the land as identifiable solely on the basis of their effects on vegetation. In a sense we need little more than a botanical map to guide us across the countryside. The physical arrangement of the land may determine what can and what cannot grow there, though species that take over soon add controls and therefore *microhabitats* of their own. These controls can be very hidden, such as the antibiotic poison that a little herb of dry uplands called "pussytoes" puts out, preventing competitors from getting too close. The controls may also be as obvious as the shade they put forth. Trees offering heavy shade would include sugar maple, beech, and hemlock; less shading would be various oaks and white pine; among the least shading are *Populus* and willow species as well as pines. With these as standards, your students might make up their own local lists. In general, the greatest shading comes from climax species, with lesser degrees of shade being found in earlier stages of forest development.

Students might find field situations easier to visualize if they record their findings in a chart form. Here is a very brief example:

FIELD NOTES

Location _____

Community _____

Topography _____

Plant Species	Percent Cover
_____	_____
_____	_____

Slopes

The driest, most exposed ridges are often occupied not by preference but by availability. Thus in some places pitch pine, red pine, or red, chestnut, and scarlet oak may flourish in the absence of competing trees. Hardy herbs like harebell, moth mullien, Pasqueflower (especially on gravelly ridges), and sandbur likewise thrive where their neighbors are few and far between.

In those parts of the country where native prairies have been reduced to relicts, North American species thrive. European plants, raised in more humid climes, find it difficult to invade, especially on dry slopes. You can see these leftover prairies even from the automobile during autumn, for they take on a pink hue as the frosts arrive. Many prairie species store food over winter, and the chemical changes in the leaves during fall are similar to those of deciduous trees so famous for autumn brilliance.

Plant succession is generally very slow on steep slopes which are underlain by sandstone, where the soil is thin and dry, nutritively poor, and acid. When plants do come in and eventually die and decay, the acids in their leaves augment the acid status of the soil, since sand contains very little lime (basic) to neutralize these chemicals. Thus in places where sandstone ridges add variety, look for it to be indicated by plant diversity (black oaks, which tolerate drought, and smaller plants that thrive on acids, such as haircap moss, pipsissewa, blueberry, pussytoes, and wild oat grass).

Trees on exposed ridges tend to show the effects of winds. If they are near the seacoast and winds carrying salt spray hit them, the buds on that side (seaward usually) are often killed or stunted and the leeward buds alone attain reasonably full growth. Such trees develop in a lopsided fashion, having a dearth of branches and foliage on the salt spray side. Sometimes the top of the crown on the leeward side spreads out as though "wind driven," a condition known to botanists as espalier growth. In mountainous areas look for similar effects near the timberline where the windward side of trees may be shorn by drying cold winds, drying sunshine, and blizzards and hail. The result may be a tree that looks like half a pyramid.

Uplands in some parts of the country, incidentally, tend to be the best places to look for Indian relics. The lowlands breed mosquitoes, but windswept ridges are fairly free of them and wise Indians often camped *there*. Thus in Indian territory here is a likely place to see how those educated in nature read the landscape before you.

Where slopes are the closely opposing walls of steep ravines, special conditions prevail. Here the effect is that of an enclosure, and we find heavy shading, capture of evaporation and stream spray, and resultant cool, moist air. This produces a special local microhabitat which is of a more northern aspect and indicates conditions that might be found some miles away to the north. So, in a part of the biome where one might commonly find oaks and red cedars on the uplands, you might actually expect more northerly species such as hemlock, yellow birch, sugar maple, and beech to occur in the canopy, with an understory of arrowwood, witch hazel, woodsorrel, and foamflower in an adjacent ravine. If you follow such a stream southward toward its mouth, you will find open banks that distinctly face the south and the north; hills and mountains have similar slopes. And the vegetation reflects the facings: south-facing slopes experience more direct sunshine and are more likely to be struck by the prevailing winds; temperature and evaporation go up, while air and soil moisture drop; north-facing slopes differ appropriately.

A *south-facing* slope in northern states can actually "acquire" a southern vegetational aspect and may thus inform you about natural landscapes too far away to take your class to. For instance, if you live near Madison, Wisconsin, and your hill has a south-facing escarpment that is about 20 degrees off the horizontal, in June it will receive sunlight somewhat similar to that which a flat land experiences at the Tropic of Cancer, about 20 degrees latitude to the south. Maple trees and hemlocks of the woods might give way up north to the more southern oaks, hickories, or prairie plants. By contrast, *north-facing* vegetation lives in a moister, cooler environment and is richer in development. The humus and leaf litter is deeper. But northerly, moisture-loving types can often follow north-facing river banks farther south or into more arid areas. Similarly, on mountains plants of the higher elevations move farther down when occupying a north-facing exposure. Around Madison a slope tilted north by only 4 degrees could receive solar radiation similar to that of a level area on the Canadian border some 300 miles to the north. A large-scale demonstration in the eastern United States of the effects of altitude and slope is found in the spur of spruce-fir and hemlock-hardwood forests that follows the Appalachian chain from Canada down into the Great Smoky Mountains of Tennessee. The major significance for this presentation is that without going far afield you may still be able to conduct very wide-ranging field trips. Knowing species' preferences might even help your students tell the north from the south side of a hill as an exercise.

Where you get direct contrasts of north- and south-facing slopes, you also find comparable differences in the *understory* indicators. For instance, shade-tolerant maidenhair ferns, thin-leaved spleenwort, and hepaticas may be matched on the other side by the tougher asters, currants, and goldenrods of the less shaded, drier environment. You may be able to compare slopes by comparing percentages of areas covered by indicator species. *Succession* on slopes may also indicate conditions of distant flatter areas your class simply could not afford to travel to.

Lowlands (wetlands)

Much of the discussion of lowlands has appeared elsewhere under general topics, but lowlands of stream sites are characteristic wetlands, and this type of environment will be emphasized here.

Hollows may form especially close-knit little macrohabitats. Thus you may expect one to contain plants that indicate soil which is wet at all times. These indicators might include nettles, elderberries, and broad-leaved docks (related to the dock from mountains in China, called "rhubarb").

Swamp forests may appear where rivers inundate the natural levees just back of the riverbank but give them enough dry time to build a land community. The climax forest that develops depends to a great extent on the local conditions (wet) and hence is called an "edaphic climax." You can read a history of flooding into these places simply by noting the plant species. Such unstable sites are filled first by fast growing weeds, the well-known nettles and giant ragweed being typical. They soon hold the soil firm and pave the way ultimately for trees, such as black willows and poplars, which may carry veils of grape vines and poison ivy. Eventually these trees are likely to prove their own species' worst enemy. Their seedlings cannot withstand the parents' shade, so the species die out. They have, however, prepared the land for those more hardy elms and maples which arrive. Further evidence you can look for of a wetlands history is often shown by the tree bases. These may become spread out or "buttressed" where conditions are particularly sodden.

In the Southeastern Evergreen Forest a swamp forest association may occur that has been variously romanticized. This is the bald cypress and tupelo wetland, grey with dripping Spanish moss. Like many trees of waterlogged situations the bases of *these* also have broad buttresses. Many textbooks have photographs of the cypress "knees" which apparently act as pneumatophores, helping supply the tree with air. Water changes play a very important role here. The water must drain away on occasion or tupelo will die out, and cypress will invade while the water is gone. Thus a delicate balance is necessary for these two trees to live together. For many ecologists the Southeastern Evergreen Forest is a challenge in that possibly it is supported largely by fire. Were there not fire, it is said, the loblolly, longleaf, and slash pines and their evergreen broadleaf associates would give way to the other species. Thus the whole area, from edaphic swamp forests to associations of the uplands may be in a constantly renewed subclimactic stage, ordered on the one hand by water and on the other by fire and indicating the intermittent presence of both. A long-term project might be to hold such a place free of fire, a possibility especially useful if your school or community is preserving a "school forest."

Sand

So much of our eastern landscape has at one time or another been submerged under seas, lakes, glaciers, or combinations of these that sand deposits here often occur in vast beds. All have at least two habitat factors in common: drought and loose soil. Plant succession will tend to begin with species that tie up the sand, often in dunes. A mat of living and dead material gathers and infiltrates the sand, and the humus percentage goes up. Shrubs and trees finally dominate the scene and stabilize the soil, unless it is subclimactic to an earlier stage.

By way of example, beach grass, sandreed grass, and quack grass are often among the first sand-binders. Sandreed grass can become a major colonizer of sand blowouts, areas where turf has been opened and the sandy substrate is revealed. The varied biennials and perennials that arrive can early give a new beach, blowout, or dune a diversified cover. On the shores of Lake Michigan a shrub stage of red-osier dogwood, sand cherry, willow, shrubby balsam poplar, and others can now come in. Sand cherry and willow shrubs are likely to be particularly common on the lee slopes, in troughs, and within the confines of blowouts. Along the Massachusetts seashore, beach plum may occupy this protected position on dunes. Eventually a drought-tolerant or deciduous tree zone appears. Mixed pine and oak will likely follow. The toughness of oak is indicated in the knotted forests of squat oak trees atop many Cape Cod cliffs. Try to learn the ages of trees in such habitats, and your students may come away amazed.

Pines and oaks of various species are old companions on sand deposits. Where oaks give way, however, look for pine to go on alone. You may look for pine woods as indicators of the sands of glacial lakes or terminal moraines. To the north, white pine may indicate wetter flats or dry terraces of gravel. Pitch pine may have tracts all to itself in the midst of southern New England oak forests. Minor fires help keep competitors out of pitch pine country. Pitch pine is one of the few conifers that can send up new growth from a stump, and so it recovers. Look for such coppice growth in reading local history.

PLANTS AS INDICATORS OF SOIL pH

When a plant responds to the pH of a soil, it may do so in accordance with many circumstances other than acidity and baseness and thus may not give a reading that is a faithful record of the pH values. By using more than one type at a time, however, you may expect to get useful results which indicate the local pH. The following plants are listed according to pH preference, and in general they will thrive best within these ranges. Making a list of species of plants indigenous to a particular part of the landscape and comparing it to the following brief list

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should give you a fair idea as to the soil pH there. (More detailed material on this can be found in the article by Lapp and Wherry[4]):

Circumneutral plants, pH 6.0-8.0: daisy, forsythia, hawthorn, jack-in-the-pulpit, arbor vitae, beech, and sugar maple.

Somewhat acid plants, pH 5.0-7.0: goldenrod, mountain laurel, pussytoes, Virginia creeper, red cedar, flowering dogwood, and striped maple.

Strongly acid plants, pH 4.0-5.0: ladyslipper, sphagnum moss, sundew, maple-leaved viburnum, mountain ash, white cedar, and scrub oak.

ANIMALS INDICATE THE NATURE OF THE LANDSCAPE

Animals generally have such diverse requirements that we usually cannot limit them to the plant territories mentioned before. But we can point out animal indicators of various ecological niches. You will find that they have peculiar value in helping you read the nature of the landscape in that, being mobile, they are able to *assemble* the parts of their ecological niches. Thus, by moving, they can attain one habitat for nesting, another for feeding, and so on. Using them you can sometimes learn about two or more widely separated places or events. Since birds are most easily seen and are likely to be most familiar to students of the out-of-doors, this account will deal largely with birds.

Open-Land Species

Birds nesting in large meadows tend to have at least one trait in common: they sing on the wing. Thus, if you are taking a class on a field trip, you may be able to point out open places from a roadside that is enclosed by shrubbery simply by noting the songs. Examples are the bobolink, goldfinch, horned lark (a true relative of the Old World skylark, it frequently sings from high in the sky), meadowlark, and red-winged blackbird (possibly the most populous bird in the United States). Again, if you are studying a field that is within the ranges of vesper sparrows and horned larks, but find none, you might guess that dense, tall grasses are dominating the scene and keeping these two species out. A somewhat more subtle hint as to the nature of the landscape is provided by the Eastern meadowlark which is dubbed an indicator bird for its territory by many ornithologists. Where such birds are common, you may expect its distinctive nesting grounds, which are primarily wetter and smaller pastures. Identify the birds to your students; then ask them what differences they have noticed in the habitats.

While frogs may surprise you by following belts of soggy lowlands which take them far from open water, toads are actually considered the most typical amphibian of old fields. They undergo the aquatic phases of their life cycle—egg and tadpole stages—in short-lived waters that depend for the most part on spring and summer rains. The presence of either amphibian indicates not only nearby water but likely also wet paths through the field.

As for mammals, a study of abandoned fields of the Southern Atlantic and Gulf states shows that pine-mice and meadow voles become particularly common as perennial broomsedge grass begins to dominate. Prairie deer mice and cottontail rabbits frequent abandoned fields in Michigan; meadow voles join them as perennial grasses take over; and the mice finally leave as mixed herbaceous perennials come in. You may guess the nature of the plants by recognizing the animals. Similarly, sandy or peaty areas may be indicated by the presence of a number of moles, which prefer loose soil.

Thicket Species

Fields which have entered the bramble, "rough stuff," or shrub-tree stage are most difficult to analyze simply because passage there is blocked by shrubbery. And much of that has thorns or is accompanied by poison ivy. Nevertheless, because they combine aspects of both fields and forests with their own rambling nature, thicket fields may rank among the most productive areas for wildlife. The zone of contact between different types of habitat is known as an "ecotone"; the developmental stage which thickets represent may be ecotonal between grassy fields and tall woods. Can you "prove" this point by having students make a list of bird or other species present there as compared to other or adjacent habitats? Presumably weedy thicket ecotones will have more species than either of the adjoining habitats. This effect which two adjoining communities have on the nature and density of species in the marginal or bordering zone is known as the "edge effect."

Suburban developments have tended to increase thicket type of habitat in the form of shrubbery, which is joined on the one hand by lawn and on the other by trees. Such birds as towhees and chestnut-sided warblers, considered indicator birds in central New England thickets, have also increased where this type of landscaping has prospered. Carry this thought further and try to picture the natural landscape as it likely was several centuries ago. Today thicket-loving birds seem very common, while forest species such as the pileated woodpecker, veery, and ovenbird, are less familiar. What do you suppose was their relative role in the 1600's when forests dominated?

Secondary Forest Species

Secondary forests are those which seek to recover the territory lost by original stands or prior stands following the originals. Most of our eastern woodland is of this sort, though now some of the oldest trees can be found in New England where farms have long since been abandoned or otherwise let go and the land has reverted. You can find farms that still show they were deserted in a

"Gold Rush." Although the anatomy of the woods seems easily divisible by simple inspection, we can clarify the picture further by noting how *birds* indicate the *state* of the natural divisions. Five of these "ecological niches" (an ecological niche is either a habitat or a way of living or both; by analogy it is one's residence and/or one's occupation) stand out:

1. Forest floor. Ruffed grouse, woodcock, worm-eating warbler, towhee, and ovenbird (needs broad leaves to build its nest like an oven, so it does not occur in forests made up wholly of conifers); all use it when it is free of dense undergrowth. Forest floors may be abandoned when there is too much human use; lack of appropriate birds indicates this.

2. Undergrowth. Only a few species, such as the Carolina wren and Canada warbler use it. Younger woods therefore have more of these, and *they* in turn indicate younger woods.

3. Lower branches. Wood thrush, blue jay, redstart, red-eyed vireo (takes insects off leaves and stiff twigs; the yielding twigs of conifers make such forests unfavorable for feeding, so the presence of the bird indicates forests that are largely deciduous).

4. Tree trunks and hollow branches. Used both for nesting and feeding, but only by a few birds, such as nuthatches, woodpeckers, creepers, titmice, barn swallows (somewhat; formerly in hollows of giant trees, which are less common today, as well as waterside and mountainside caves; has found a bonanza in the coming of European man with his buildings). Barn swallows and woodpeckers in particular indicate trees with holes suggestive of insect and fungal damage. Bluebirds often use abandoned woodpecker holes, so their presence may indicate these.

5. Higher branches and tree tops. Hawks, owls, crow; note that these are the larger birds we are familiar with; one reason for this is that they need strong branches to hold their nests, thus indicating a woods of more mature trees. To these species you can add some smaller birds, such as most of the warblers, the scarlet tanager, and the oriole. Incidentally, try keeping a record of Baltimore oriole nesting sites *within* the city and see if the birds don't commonly choose limbs that project out over streets. They also nest in similar positions over streams. Could it be that streets suggest streams to the orioles? Your students might carry tally sheets to make a record of places where they have seen nests; the gathering information might even be totalled on a city map in the classroom. Is it possible that the orioles are now indicators of streets?

PRACTICE

You can begin in any habitat by asking: "What is here now? What was here before? What is likely to follow? And what forces operate in each case to make this so?" Let us look at four wide-ranging situations:

1. A field with the wetland indicators (smartweed, buttonbush, willow, etc.). Do these indicate damp conditions due to water being supplied fairly regularly or water being held, though supplied intermittently? In the first case you might look for a half-hidden sluggish stream. In the second, check the soil characteristics for slow-draining clays (notice that the particles are fine and when damp can be pressed into a longish "leaf" of soil that retains its shape quite well). You may even have a perched water table, where the underlying bed prevents water from draining away easily.

One interesting indicator of the nature of the slope of a hillside is the pooling or banding of dock or yellow rocket (winter cress). You may notice these especially in a stand of something else, such as oats. The forb seeds are carried down the hillside by rainwater until they are stopped, as by a depression or ridge. Here they germinate and form pools or bands of a different species that records the local topography (which might not be easily discernible otherwise).

What was here before? A hummocky situation may show when cattle have trodden a damp meadow into pits and pillows. Invaders of moist spots that are high in nutrients, perhaps due to manure having been used as a garden or barnyard fertilizer, might include the nitrophilous (nitrogen-loving) burdock, crabgrass, black nightshade, and nettle.

What might the future bring? Again, the story of natural succession should help. But how might a landowner landscape it? He might choose river birch, willows, green or white ash, or sycamore. The peeling reddish bark of river birch contrasts nicely with the yellow twigs hanging from black willow (our only native willow to gain tree size) during spring. Arbor vitae, selected for both globe and pyramid shapes, might be an excellent choice for evergreen diversity. As a matter of fact, if you notice some of these already present, see whether their pattern doesn't suggest some earlier attempts at landscape architecture. Trees in straight lines and "exotics" are often tell-tale signs.

For upland fields notice whether development, as you have seen it in everyday usage, doesn't tend to ride over topographical differences and attempt to obliterate them rather than build *with* them. Thus lowlands, where the richest soil has collected, and uplands, where some rocky hillsides can support little other than perhaps buildings, are treated alike. Why not have each natural region for its own "best" contribution?

2. The small woodlot, so familiar in the suburbs and the foundation for many if not most of our city parks. It is often called a "secondary forest" or "secondary growth" for being the new growth after a previous forest has been cut or burned over or otherwise decimated.

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What was here before? The amount of *open space* alone, aside from the species make-up, should hint as to the stage of succession the forest is in. A woodland choked with undergrowth tells of a fairly youthful stage, perhaps open land that was allowed to turn to woods within time recent enough for local citizens to remember the old ways. (Area maps, historical society records, and other materials in the archives can help clarify the situation, of course, but try to hold off as long as possible as far as students are concerned. Naturally these historical aids will be useful in your own preparing.) Now you can begin to estimate the ages of trees to tell you when things occurred.

Until you gain enough experience to judge roughly by sight, you will find an increment borer a very handy instrument. By taking a series of cores from trees (always sinking the tube in at a slightly upward angle so that water and sap run out and thus minimize the danger of infection), you will be able to draw a pretty fair sketch of the ages of sections of the woods. An even-aged stand (plants of approximately the same age) suggests uniform history. Sections of land may have been let go one at a time as a farmer gave up. Does the new growth suggest very slow or very fast draining conditions (both potential reasons for changing agricultural practices)? In another case a town may have developed along a stream bed, but the landowners eventually sold out because of spring floods (which may have primarily ruined potato cellars and storage in general).

The placement of undergrowth and larger trees can tell a great deal. Some of the smaller trees and shrubby growth, if strung out in a line, may indicate a former hedge or natural fence. Unusual flowers, not common to woodlots, tell of gardens, sidewalks, doorways (is there any evidence of old foundations?). Orchard trees may mean a family tree or so rather than a massive planting–especially if near a presumed house. Large trees that spread out laterally for great distances and thus dominate a fair chunk of territory beneath them (due to shading and other factors) are often called "wolf trees," for the tendency to devour territory. Such lone, large trees may have been household favorites, or possibly shade trees left in the pasture, or even the corner marker to a lot. They may also be survivors of fire. Wolf trees provide excellent studies. Not only may they represent what was to have been the future of the area, but plants growing beneath them are likely to tell the *next* stage. If this understory is the same species as that very tree, then *it* may indeed be a climax species for the area.

Notice whether the branches spread out horizontally or are pinched upwards. (Compare them with other trees of the same species so you are sure just what the species capability is.) Horizontal growth generally comes with having few large neighbors; pinched growth suggests crowded situations. A tree's crown may show both open and crowded effects, perhaps from growing at the edge of a woods that was cut back regularly. Individual trees or clumps growing amid trees that occur later in the successional ladder, such as birches in the midst of giant oaks, suggest invasion after catastrophe; a forest fire or even the death of a single large tree can open up the woods to these temporary guests. In many cases, incidentally, not only can you make a guess as to the sort of history, but you can possibly even guess the nature of the soil. Grey birch is your clue to dry, poor, nearly worn out soil, while white birch tells of good soil and potential for a return to hardwoods.

One further note: Be on the lookout for events that may throw a trick at your estimates of age. For instance, consider two white pines growing side by side, one straight and tall and full-crowned and the other small and crooked. The latter may be the older by more than a century; unfortunately it may have had to struggle against pine tip weevils which kept destroying the tips, forcing the tree to produce new shoots. Its climb upward was slow and tortuous, as evidence shows. Things were different later for the younger tree.

3. Eurasian man's path in North America, as traced via weeds and other travelers.

Common dandelion, which infests our lawns so regularly, came here as a vigorous "weed" from Europe. So did many other fast-growing, short-lived plants that can take a tough life, especially that offered by bared soil. They rush into about every place we cut open. You can add black mustard, peppermint and spearmint, sow-thistle, tansy, and teasel to mention just a few more. But do not forget those which have long been deliberately added to our openings in the soil, long before any were raised for beauty. Note the Irish potato. Corn is a native example–not brought from Eurasia by white men. Both are definitely definable as "weeds." Of course we already had natives which flourished behind the plow and shovel as they opened new territories. A few of the more familiar ones are barnyard grass, alfalfa, milkweed (how long has it supported the migratory habits of the Monarch butterfly?), heal-all, ragweed, evening primrose, and horseweed.

With such a list in hand, can you read from the land about you how effectively our ancestors have released the weedy invasion? (By 1672 John Josselyn had noted that forty or so kinds of weeds had appeared since the English opened up New England with seed and cattle.) You might compare native versus non-native species today, using such a field guide as E. Laurence Palmer's book. [5] An occasional gem of travel may turn up. While considering the success of weeds and other travelers, you might look into their predecessors. Ask the question "What has made the difference?" Some species may have taken the fertilizer routes behind cultivation and livestock. Others may have simply taken advantage of breaks, such as sandblows that follow overgrazing and other damages to sandy soil.

Woodland flowers are likely to be natives, incidentally, which are more shade-tolerant than European forms.

4. For a final practice, show your students a picture or give them a description of some bit of terrain. Ask them to diagram what it was perhaps like 20, 50, even 100 years ago—or what might happen naturally (or not) in the future. Again, you might present habitats and ask the students to fill in the present details. Or offer a regional view with species identified (a common physiographic map is an example) and ask for a terrain description. If you work from observation to interpretation, and if you encourage your students to apply principles, you will soon have them reading the landscape as just a part of everyday life.

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What evidence of floodplain activity?

Buckthorn on dry uplands of juniper and sparse cover, browsed to cone shape by cattle.

A spring ephemeral (such as hepatica, bloodroot, [illegible]

On the tree: evidence in parallel of prior land use.

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